Mechanism for the Detection of Aircraft and Missiles via Atmospheric Ion Trail Detection by Light-Delay Measurement in the Terahertz Domain

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Introduction

The detection of aircraft and missiles via infrared signatures has improved dramatically over the past 25 years, enabling space-based detection of aircraft producing meaningful IR energy. However, IR-based detection systems have limitations. Heat-seeking missiles such as the Sidewinder had to be improved by turning them into hybrid heat-seeking/RADAR-guided missiles as the RADAR-guidance technology became sufficiently miniaturized in order to allow both tracking mechanisms to be used in the same compact missile.

The advent of photo-magnetic propulsion systems and the ever-present potential for the generation of IR interference from everything from aviation flares to directed energy weapons aimed at our IR satellites recommends a novel detection mechanism never before proposed.

Abstract

When an aircraft passes through the atmosphere, the heat it introduces and, more to the point, its wake results in the convection of atmosphere in the wake of the aircraft. Pockets of swirling air move in opposing directions and these pockets give rise to a series of increasingly diminutive but multiplicitous areas of swirling air. These sorts of pockets of air are easily visible using Schlieren Imaging, but this imaging system requires that a perfect optical mirror be placed behind the area of atmosphere to be measured.

Even if no heat is generated by the propulsion system of an aircraft or missile, the fact that the object has a wake will cause the atmosphere to turbulate and this turbulation will result in the ionization of the atmosphere in the wake of the aircraft.

If we were to emit Terahertz-band energy between constituents of a network of LEO satellites so that the energy is directed in such a manner so as to barely clear the horizon, the time-of-flight of the electromagnetism could be measured by a precision clock. It could be predicted that an ion trail, even a faint one, would cause the electromagnetism to take slightly longer to arrive at its destination. If the relative position of the satellites is known to a high degree of precision and if natural phenomenon such electrical storms were not present in the measured area, increases to the time-of-flight of a Terahertz-band signal could be used to infer the presence of an ion trail.

The emitters could also be positioned on the ground and could emit energy toward known satellites in Low-Earth Orbit. Even smaller aircraft such as quad-copter style drones would produce an ion trail as a result of the friction of the propellers with the atmosphere, which is non-trivial.

What is being measured, in this case, is not the presence of air molecules with greater or lesser than normal numbers of electrons, but rather, the presence of electrons in-transit as they move between the air molecules to seek equilibrium. The free electrons associated with these nano-discharges, although difficult to detect with magnetometers, slow light and other EM more than electrons which are in stable orbits around atoms.

This technique may be prove indispensable for both drone detection and for the detection of revolutionary aircraft which are both difficult to detect on RADAR and which do not have readily measured IR signatures. This system would infer the presence of ion trails not through direct measurement of the ionized air, but through the measurement of light-slowing effects unique to free electrons moving between air of opposing ionizations. Just as water vapor has entirely different optical properties when it is separated from air molecules (as in a water vapor contrail,) electrons have entirely different effects upon electromagnetism in flight when they are uncoupled from orbitals and are in free flight. The property associated with flowing electrons in this context which can most readily be exploited for aircraft/drone/missile detection is the light-slowing effect. Precision chronometers sc. OASICs of sufficient miniaturization and precision now exist so as to enable these effects to be measured.

Repeated measurements from multiple angles would be required in order to narrow the possible range of origin-points of the light-slowing effects so that aircraft could be dispatched to meet the intruding aircraft.